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(54) **SYSTEMS AND METHODS OF DISTRIBUTING COLD CHAIN DIAGNOSTICS TO OWN AND THIRD PARTY COLD CHAIN, TRUCKING AND REFRIGERATION SOLUTION PROVIDERS**

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See application file for complete search history.

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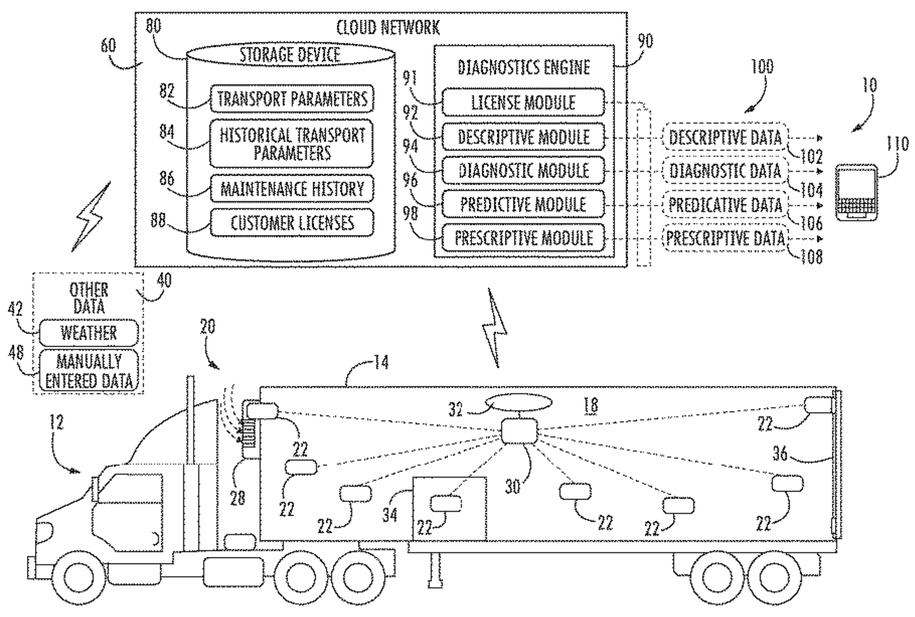
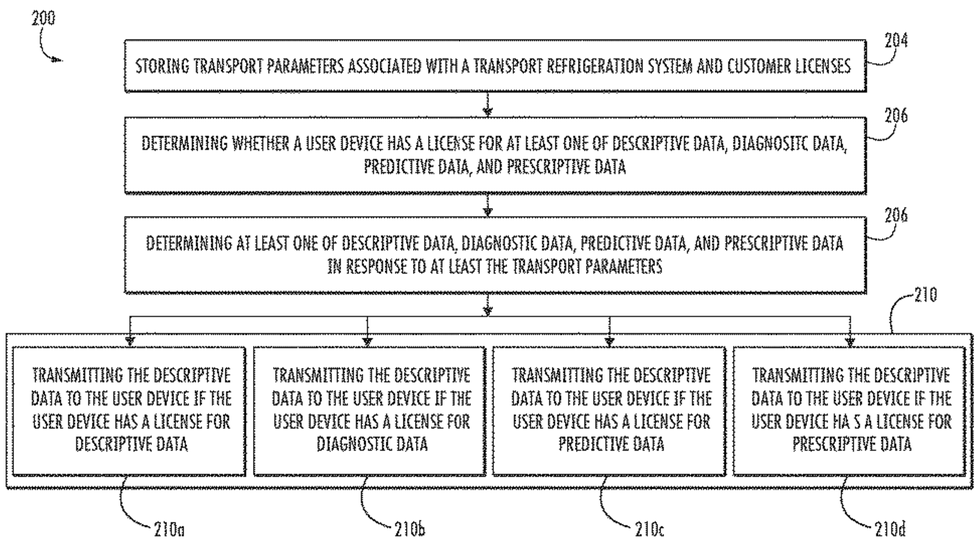
(57) **ABSTRACT**

A system for analyzing a transport refrigeration system including: a storage device to store transport parameters associated with a transport refrigeration system and customer licenses; a diagnostics engine in electronic communication with the storage device, the diagnostics engine including: a license module to determine whether a user device has a customer license for at least one of descriptive data, diagnostic data, predictive data, and prescriptive data; a descriptive module to determine descriptive data in
(Continued)





response to at least the transport parameters; a diagnostic module to determine diagnostic data of the transport refrigeration unit in response to at least the transport parameters; a predictive module to determine predictive data; and a prescriptive module to determine prescriptive data.

20 Claims, 2 Drawing Sheets

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G06Q 50/30 (2012.01)
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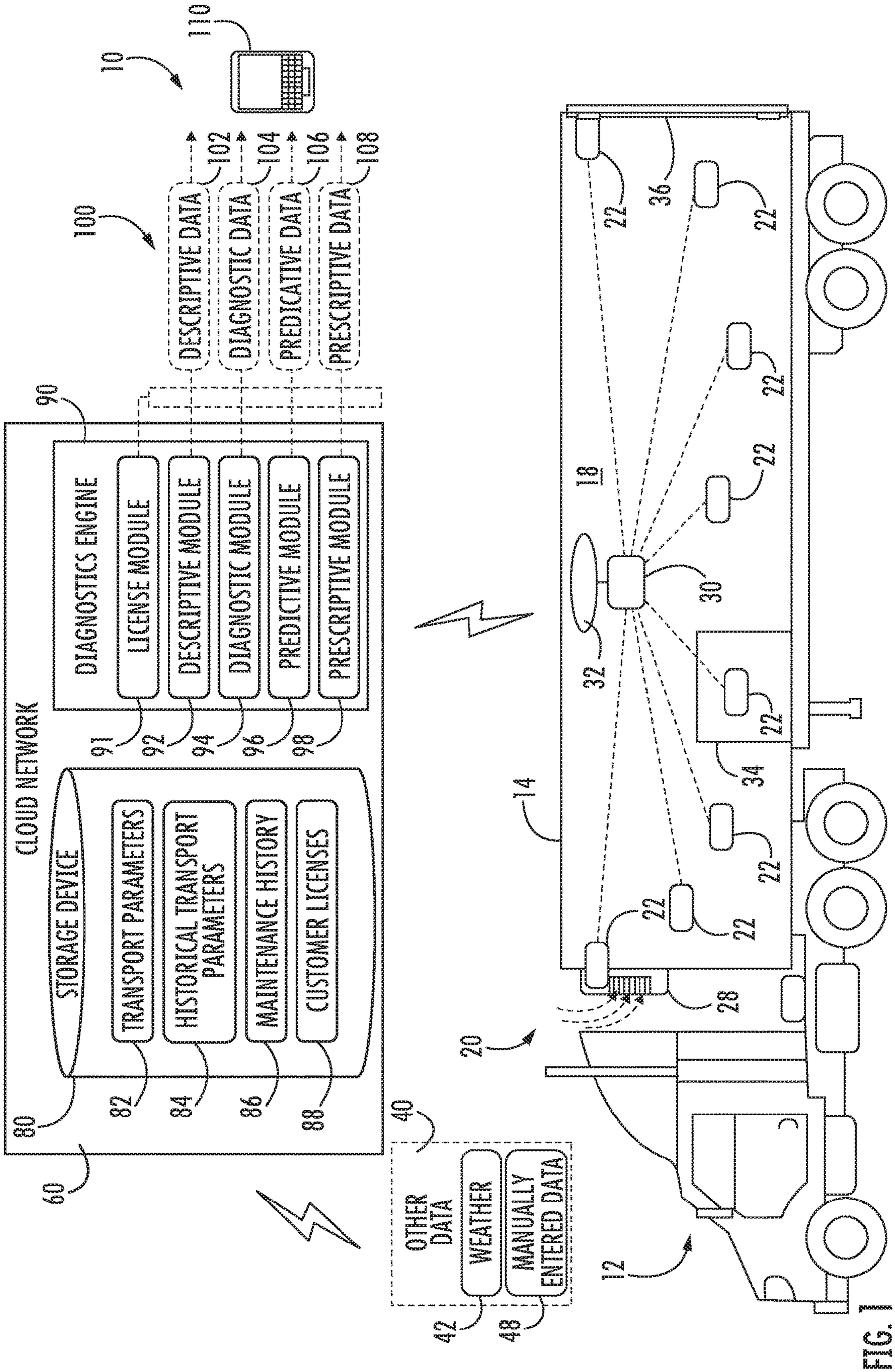
10
110
100
DESCRIPTIVE DATA
DIAGNOSTIC DATA
PREDICATIVE DATA
PRESCRIPTIVE DATA
102
104
106
108
90
DIAGNOSTICS ENGINE
LICENSE MODULE
DESCRIPTIVE MODULE
DIAGNOSTIC MODULE
PREDICTIVE MODULE
PRESCRIPTIVE MODULE
91
92
94
96
98
CLOUD NETWORK
STORAGE DEVICE
TRANSPORT PARAMETERS
HISTORICAL TRANSPORT PARAMETERS
MAINTENANCE HISTORY
CUSTOMER LICENSES
80
82
84
86
88
60
OTHER DATA
WEATHER
MANUALLY ENTERED DATA
40
42
48
14
20
12
18
22
30
32
34
36
28

FIG. 1

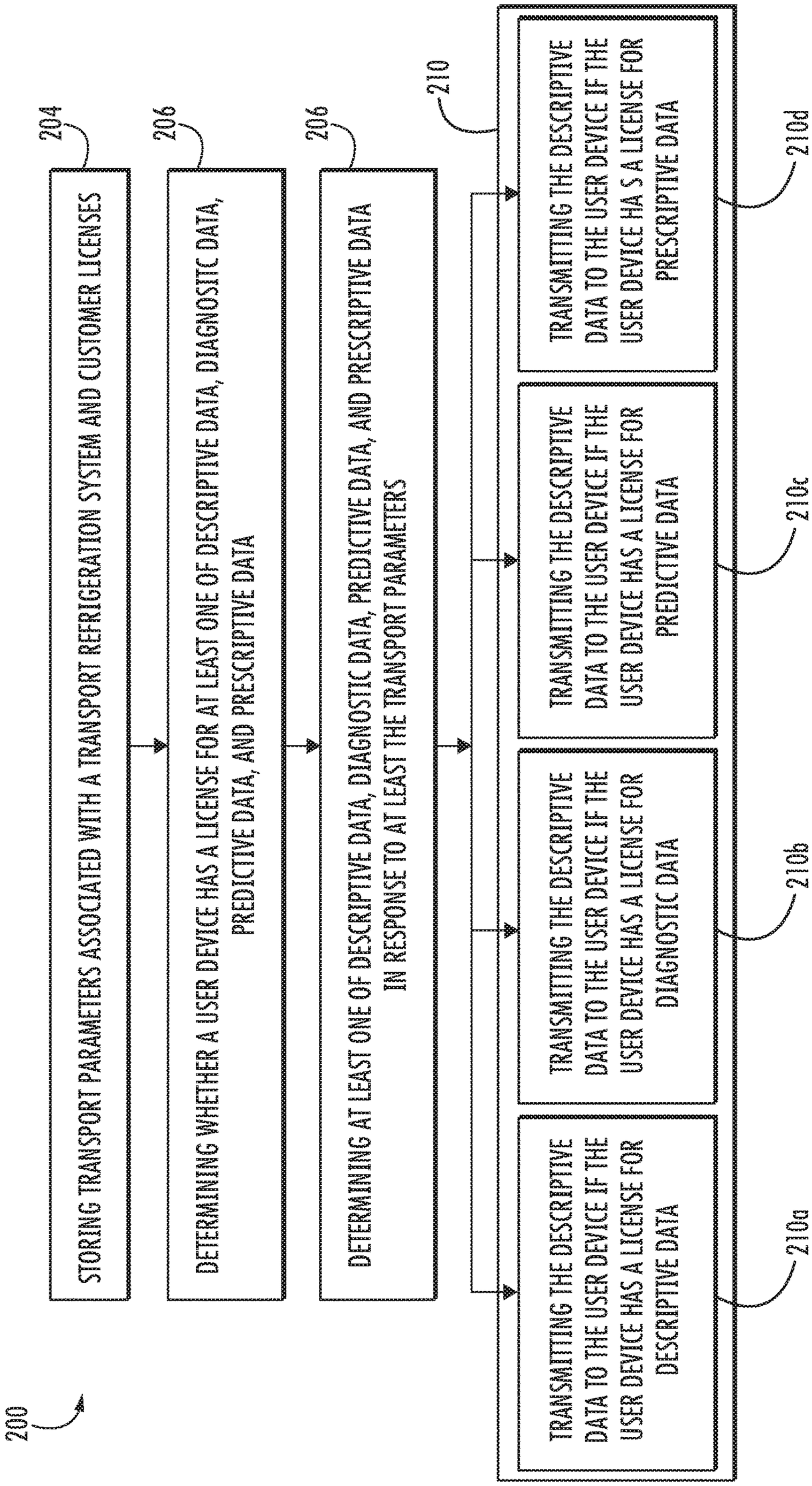
200
STORING TRANSPORT PARAMETERS ASSOCIATED WITH A TRANSPORT REFRIGERATION SYSTEM AND CUSTOMER LICENSES
204
DETERMINING WHETHER A USER DEVICE HAS A LICENSE FOR AT LEAST ONE OF DESCRIPTIVE DATA, DIAGNOSITC DATA, PREDICTIVE DATA, AND PRESCRIPTIVE DATA
206
DETERMINING AT LEAST ONE OF DESCRIPTIVE DATA, DIAGNOSTIC DATA, PREDICTIVE DATA, AND PRESCRIPTIVE DATA IN RESPONSE TO AT LEAST THE TRANSPORT PARAMETERS
206
210
TRANSMITTING THE DESCRIPTIVE DATA TO THE USER DEVICE IF THE USER DEVICE HAS A LICENSE FOR DESCRIPTIVE DATA
210a
TRANSMITTING THE DESCRIPTIVE DATA TO THE USER DEVICE IF THE USER DEVICE HAS A LICENSE FOR DIAGNOSTIC DATA
210b
TRANSMITTING THE DESCRIPTIVE DATA TO THE USER DEVICE IF THE USER DEVICE HAS A LICENSE FOR PREDICTIVE DATA
210c
TRANSMITTING THE DESCRIPTIVE DATA TO THE USER DEVICE IF THE USER DEVICE HA S A LICENSE FOR PRESCRIPTIVE DATA
210d

FIG. 2

SYSTEMS AND METHODS OF DISTRIBUTING COLD CHAIN DIAGNOSTICS TO OWN AND THIRD PARTY COLD CHAIN, TRUCKING AND REFRIGERATION SOLUTION PROVIDERS

BACKGROUND

The subject matter disclosed herein generally relates to cold chain distribution systems, and more specifically to an apparatus and a method for analyzing cold chain distribution system.

Typically, cold chain distribution systems are used to transport and distribute perishable goods and environmentally sensitive goods (herein referred to as perishable goods) that may be susceptible to temperature, humidity, and other environmental factors. Perishable goods may include but are not limited to fruits, vegetables, grains, beans, nuts, eggs, dairy, seed, flowers, meat, poultry, fish, ice, and pharmaceuticals. Advantageously, cold chain distribution systems allow perishable goods to be effectively transported and distributed without damage or other undesirable effects.

Refrigerated trucks and trailers are commonly used to transport perishable goods in a cold chain distribution system. A transport refrigeration system is mounted to the truck or to the trailer in operative association with a cargo space defined within the truck or trailer for maintaining a controlled temperature environment within the cargo space.

Conventionally, transport refrigeration systems used in connection with refrigerated trucks and refrigerated trailers include a transport refrigeration unit having a refrigerant compressor, a condenser with one or more associated condenser fans, an expansion device, and an evaporator with one or more associated evaporator fans, which are connected via appropriate refrigerant lines in a closed refrigerant flow circuit. Air or an air/gas mixture is drawn from the interior volume of the cargo space by means of the evaporator fan(s) associated with the evaporator, passed through the airside of the evaporator in heat exchange relationship with refrigerant whereby the refrigerant absorbs heat from the air, thereby cooling the air. The cooled air is then supplied back to the cargo space.

In conventional systems, maintenance for transport refrigeration systems is conducted utilizing planned maintenance activities performed at selected intervals for all transportation refrigeration systems.

BRIEF SUMMARY

According to one embodiment, a system for analyzing a transport refrigeration system is provided. The system including: a storage device to store transport parameters associated with a transport refrigeration system and customer licenses; a diagnostics engine in electronic communication with the storage device, the diagnostics engine including: a license module to determine whether a user device has a customer license for at least one of descriptive data, diagnostic data, predictive data, and prescriptive data; a descriptive module to determine descriptive data in response to at least the transport parameters and transmit the descriptive data to the user device if the user device has a customer license for descriptive data; a diagnostic module to determine diagnostic data of the transport refrigeration unit in response to at least the transport parameters and transmit the diagnostic data to the user device if the user device has a customer license for diagnostic data; a predictive module to determine predictive data in response to at least the transport parameters and transmit the predictive data to the user device if the user device has a customer license for predictive data; and a prescriptive module to determine prescriptive data in response to at least the transport parameters and transmit the prescriptive data to the user device if the user device has a customer license for prescriptive data.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the storage device stores historical transport parameters for the transport refrigeration system.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the storage device stores a maintenance history of the transportation refrigeration system.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the descriptive module determines descriptive data in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the diagnostic module determines diagnostic data in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the predictive module determines predictive data in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the prescriptive module determines prescriptive data in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the descriptive module determines descriptive data in response to the transport parameters and the maintenance history.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the diagnostic module determines diagnostic data in response to the transport parameters and the maintenance history.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the predictive module determines predictive data in response to the transport parameters and the maintenance history.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the prescriptive module determines prescriptive data in response to the transport parameters and the maintenance history.

According to another embodiment, a method for analyzing a transport refrigeration system is provided. The method including: storing transport parameters associated with a transport refrigeration system and customer licenses; determining whether a user device has a customer license for at least one of descriptive data, diagnostic data, predictive data, and prescriptive data; determining at least one of descriptive data, diagnostic data, predictive data, and prescriptive data in response to at least the transport parameters; transmitting the descriptive data to the user device if the user device has a customer license for descriptive data; transmitting the diagnostic data to the user device if the user device has a customer license for diagnostic data; transmitting the predictive data to the user device if the user device has a

customer license for predictive data; and transmitting the prescriptive data to the user device if the user device has a customer license for prescriptive data.

In addition to one or more of the features described above, or as an alternative, further embodiments may include: storing historical transport parameters for the transport refrigeration system.

In addition to one or more of the features described above, or as an alternative, further embodiments may include: storing a maintenance history of the transportation refrigeration system.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the descriptive data is determined in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the diagnostic data is determined in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the predictive data is determined in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the prescriptive data is determined in response to the transport parameters and historical transport parameters.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the descriptive data is determined in response to the transport parameters and the maintenance history.

In addition to one or more of the features described above, or as an alternative, further embodiments may include that the diagnostic data is determined in response to the transport parameters and the maintenance history.

Technical effects of embodiments of the present disclosure include delivering different levels of data for analysis of a transportation refrigeration system in response to a license of a user

The foregoing features and elements may be combined in various combinations without exclusivity, unless expressly indicated otherwise. These features and elements as well as the operation thereof will become more apparent in light of the following description and the accompanying drawings. It should be understood, however, that the following description and drawings are intended to be illustrative and explanatory in nature and non-limiting.

BRIEF DESCRIPTION

The subject matter which is regarded as the disclosure is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features and advantages of the disclosure are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. **1** illustrates a schematic view of a system for analyzing refrigeration system, according to an embodiment of the present disclosure; and

FIG. **2** is a flow diagram illustrating a method for analyzing a refrigeration system, according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

Referring now to the drawings, FIG. **1** illustrates a schematic view of a system **10** for providing analytics for refrigeration transportation systems. Typically, transport refrigeration systems **20** are used to transport and distribute perishable goods and environmentally sensitive goods (herein referred to as perishable goods **34**). In the illustrated embodiment, a transport refrigeration system **20** includes an environmentally controlled container **14**, a transport refrigeration unit **28** and perishable goods **34**. The container **14** may be pulled by a vehicle **12**. It is understood that embodiments described herein may be applied to shipping containers that are shipped by rail, sea, air, or any other suitable container, thus the vehicle may be a truck, train, boat, airplane, helicopter . . . etc. The container **14** may define an interior compartment **18**.

In the illustrated embodiment, the transport refrigeration unit **28** is associated with a container **14** to provide desired environmental parameters, such as, for example temperature, pressure, humidity, carbon dioxide, ethylene, ozone, light exposure, vibration exposure, and other conditions to the interior compartment **18**. In further embodiments, the transport refrigeration unit **28** is a refrigeration system capable of providing a desired temperature and humidity range. The transportation refrigeration unit (TRU) **28** may be powered by an energy source such as, for example, gasoline, diesel, electricity, or another known energy source to a person skilled in the art. The perishable goods **34** may include but are not limited to fruits, vegetables, grains, beans, nuts, eggs, dairy, seed, flowers, meat, poultry, fish, ice, blood, pharmaceuticals, or any other suitable cargo requiring cold chain transport.

In the illustrated embodiment, the transport refrigeration system **20** includes sensors **22**. The sensors **22** may be utilized to monitor transport parameters **82** internal and external to the container **14**. The transport parameters **82** data of the perishable goods **34** being transported by the transport refrigeration system **20**, data of the transport refrigeration unit **28**, and/or data of the overall transportation refrigeration system **20**, as described further below. The transport parameters **82** monitored by the sensors **22** may include but are not limited to temperature, pressure, humidity, carbon dioxide, ethylene, ozone, light exposure, vibrations, and other conditions in the interior compartment **18**. Accordingly, suitable sensors **22** are utilized to monitor the desired parameters. Advantageously, sensors **22** may be selected for certain applications depending on the perishable cargo to be monitored and the corresponding environmental sensitivities. In an embodiment, temperatures are monitored. In certain embodiments, a user desires to maintain and monitor temperatures or other parameters within an acceptable range. As seen in FIG. **1**, the sensors **22** may be placed directly on the perishable goods **34**.

Further, as in the illustrated embodiment, sensors **22** may be used to monitor various transport parameters **82** of the transport refrigeration system **20**. These sensors **22** may be placed in a variety of locations including but not limited to on the transport refrigeration unit **28**, on a door **36** of the container **14** and throughout the interior compartment **18**. The sensors **22** may be placed directly within the transport refrigeration unit **28** to monitor the performance and power usage of the transport refrigeration unit **28**. Individual com-

ponents internal to the transport refrigeration unit **28** may also be monitored by sensors **22** to detect performance aspects, such as, for example usage cycles, duration, temperatures and pressure of individual components. As seen, the sensors **22** may also be placed on the door **36** of the container **14** to monitor the position of the door **36**. Whether the door **36** is open or closed affects both the temperature of the container **14** and the performance of the transport refrigeration unit **28**. For instance, in hot weather, an open door **36** will allow cooled air to escape from the container **14**, causing the temperature of the interior compartment **18** to rise, which creates additional stress on the transport refrigeration unit **28** by forcing the transport refrigeration unit **28** to work harder to cool the interior compartment **18**. Additionally, the global positioning system (GPS) location may also be detected by the sensors **22**. The GPS location may help in providing information from other data sources **40** regarding local weather **42** (including solar gain) experienced by the container **14** along the travel route. The local weather **42** affects the temperature of the container **14** and thus affects the operation of the transport refrigeration unit **28**. For instance, the transport refrigeration unit **28** may have to work harder on a container **14** travelling through a desert that is exposed to long period of heat and solar gain.

As illustrated in FIG. **1**, the transport refrigeration system **20** may further include, a controller **30** configured to log a plurality of readings from the sensors **22**, known as transport parameters **82**, at a selected sampling rate. The controller **30** may be enclosed within the transport refrigeration unit **28** or separate from the transport refrigeration unit **28** as illustrated. The transport parameters **82** may further be augmented with time, position stamps or other relevant information. The controller **30** may also include a processor (not shown) and an associated memory (not shown). The processor may be but is not limited to a single-processor or multi-processor system of any of a wide array of possible architectures, including field programmable gate array (FPGA), central processing unit (CPU), application specific integrated circuits (ASIC), digital signal processor (DSP) or graphics processing unit (GPU) hardware arranged homogenously or heterogeneously. The memory may be but is not limited to a random access memory (RAM), read only memory (ROM), or other electronic, optical, magnetic or any other computer readable medium.

In an illustrated embodiment, the transport refrigeration system **20** may include a communication module **32** in operative communication with the controller **30** and in wireless operative communication with a cloud network **60**. The communication module **32** is configured to transmit the transport parameters **82** to the cloud network **60** via wireless communication. The wireless communication may be, but is not limited to, radio, microwave, cellular, satellite, or another wireless communication method. The cloud network **60** may be but is not limited to satellite networks, cellular networks, wide area network, or another type of wireless network. The communication module **32** may include a short range interface, wherein the short range interface includes at least one of a wired interface, an optical interface, and a short range wireless interface.

Transport parameters **82** may also be provided by other data sources **40**, as illustrated in FIG. **1**. The other data sources **40** may include, but are not limited to, weather **42** and manually entered data **48**. The weather **42**, as discussed above, has an effect on the operation of the transport refrigeration unit **28** by influencing the temperature of the container **14** during transport (e.g. **210** and **214**) but the weather **42** also has other influences on the transport refrigeration unit **28**. While the system **10** includes sensors **22** to aid in automation, often times the need for manual data entry is unavoidable. The manually entered data **48** may be input via a variety of devices including but not limited to a cellular phone, tablet, laptop, smartwatch, a desktop computer or any other similar data input device known to one of skill in the art.

Data sources **40** may also include: information about the perishable goods **34** being transported that may be received though an electronic interface, or may be manually input. Knowing the perishable goods **34** (e.g., ice cream vs strawberries) could affect the diagnostic information later on since the cold mass can affect the rate at which the return air temperature readings change. Other data sources **40** may include offline data files for legacy refrigeration systems, refrigeration system applications, including third party refrigeration systems and applications (i.e., not owned by the same owner of the diagnostics engine **90**).

Other data sources **40** may also include other csv, json formats from non-carrier refrigeration systems and provide diagnostics based on a license granted to the client (i.e., owner/operator of the transportation refrigeration unit **28**). Alternatively, the client could provide input parameters (e.g., transport parameters **82**) for an available diagnostics (descriptive to prescriptive) based on the license they have and get the insights (e.g., output data **100**, see below) in response to the input parameters. For example: a small third party refrigeration provider could procure a license and provide input parameters (e.g., transport parameters **82**) to obtain output data **100** discussed below.

In the illustrated embodiment, the system **10** further includes a diagnostics engine **90** and a storage device **80** operably associated with the diagnostics engine **90**. The diagnostics engine **90** and the storage device **60** may be located within the cloud network **60**. It should be appreciated that, although particular systems are separately defined in the schematic block diagrams, each or any of the systems may be otherwise combined or separated via hardware and/or software. The diagnostics engine **90** is in electronic communication with the storage device **60**. The diagnostics engine **90** may be or include a processor including but not limited to a single-processor or multi-processor system of any of a wide array of possible architectures, including field programmable gate array (FPGA), central processing unit (CPU), application specific integrated circuits (ASIC), digital signal processor (DSP) or graphics processing unit (GPU) hardware arranged homogenously or heterogeneously. The storage device **80** may be but is not limited to a random access memory (RAM), read only memory (ROM), or other electronic, optical, magnetic or any other computer readable medium.

The storage device **80** is configured to store transport parameters **82** associated with the transport refrigeration unit **28**, historical transport parameters **84**, maintenance history **86** of the transport refrigeration unit **28**, and customer licenses **88**. The storage device **80** may be but is not limited to a random access memory (RAM), read only memory (ROM), or other electronic, optical, magnetic or any other computer readable medium.

The diagnostics engine **90** may include a license manager **91**, a diagnostic module **94**, a predictive module **96**, and a prescriptive module **98**. The license manager **91** is configured to determine what type of customer license **88** a particular user (e.g., customer, client, etc.) has by checking the customer licenses **88** stored in the storage device **80** and then determine what data **100** may be sent to a user device **110** of that user based upon their customer license **88**. For

example, a client may have only paid for a customer license **88** to receive descriptive data **102** and thus the customer will only receive descriptive data to their user device **110**. The user device **110** may be a computing device such as a desktop computer. The user device **110** may also be a mobile computing device that is typically carried by a person, such as, for example a phone, PDA, smart watch, tablet, laptop, etc. The user device **110** may also be two separate devices that are synced together such as, for example, a cellular phone and a desktop computer synced over an internet connection.

The descriptive module organize the transport parameters and transmit the transport parameters as descriptive data **102** to a user device **110**. No or very little analysis may be may be associated with the descriptive data **102**. For example, the descriptive data **102** may include power usage of the transportation refrigeration system **20**.

The diagnostic module **94** determines diagnostics data **104** of the transport refrigeration unit **28** in response to the transport parameters **82**. The diagnostic module **94** may determine diagnostic data **104** including faults in the transport refrigeration unit **28** and a potential sources for the fault. The diagnostic module **94** is configured to transmit diagnostic data **104** to user devices **110**. The diagnostic module **94** may compare the transport parameters **82** to various thresholds, limits, and ranges, to detect the diagnostic data **104** and then access historical transport parameters **84** to derive one or more potential sources for the fault. For example, the diagnostic data **104** may include power usage of the transportation refrigeration system **20** and diagnosis what is causing the power usage and power efficiency of each component in the transportation refrigeration system **20**.

The predictive module **96** determines predictive data **106** in response to the transport parameters **82**. The predictive data **106** predict future potential faults and a remaining life of at least one component of the transport refrigeration unit **28**. The predictive module **96** is configured to transmit predictive data **106** to user devices **110**. The predictive module **96** may detect patterns in the transport parameters (e.g., patterns of high/low compressor outlet pressure) to predict a failure. The predictive module **96** may use a baseline life curve which provides remaining life as a function of time. The baseline life curve may be generated based on the historical transport parameters **84**. The baseline life curve may be adjusted or shifted in response to events or transport parameters **82**. For example, detection of operation under harsh high ambient conditions may reduce the remaining life whereas the occurrence of a maintenance operation may extend the remaining life. In another example, the predictive data **106** may include a predicted power usage of each component of the transportation refrigeration system **20** and also predict the power efficiency of each component of the transportation refrigeration **20**.

The prescriptive module **108** determines prescriptive data **108** in response to the transport parameters **82**. The predictive module **96** is configured to transmit prescriptive data **108** to user devices **110**. The prescriptive data **108** may include a recommendation for upcoming maintenance of the transport refrigeration unit **28**. The prescriptive module **108** may detect trends in the transport parameters **82**, compare the transport parameters **82** to thresholds and/or determine rates of change of in transport parameters **82** to determine a need for preventative maintenance. The existence of a series of alarm occurrences (e.g., over-pressure) may indicate the need for preventative maintenance. In an example, the prescriptive data **108** may include a recommendation on how to change power usage and/or power efficiency of each component of the transportation refrigeration system **20**.

The diagnostic module **94**, predictive module **96**, and prescriptive module **98** may utilize historical transport parameters **84** from other transport refrigeration units and the maintenance history **86** of the current transport refrigeration unit **28** in their determinations. The historical transport parameters **84** may provide information such as, for example, life curves, failure rates, and a selected range of conditions for each component of the transport refrigeration unit **28**. The selected range of conditions may define the normal operating conditions of component of the transport refrigeration unit **28**. Operation outside of the selected range of conditions may indicate an issue with a component of the transport refrigeration unit **28**. The maintenance history **86** may help indicate persistent issues with a component of the transport refrigeration unit **28**. The maintenance history **86** may also help the predictive module **96** adjust the maintenance schedule of the transport refrigeration unit **28**.

Advantageously, as provided herein, the diagnostics engine **90** may provide data **100** at various levels to help to better predict maintenance schedules and reduce unplanned down time of the transport refrigeration system **20**.

Referring now to FIG. **2** with continued reference to FIG. **1**. FIG. **2** shows a flow diagram illustrating a method **200** for analyzing a transport refrigeration system **20**, according to an embodiment of the present disclosure. At block **204**, transport parameters **82** associated with a transport refrigeration system and customer licenses **88** are stored on a storage device **80**. A block **206**, it is determined whether a user device **110** has a customer license **88** for at least one of descriptive data **102**, diagnostic data **104**, predictive data **106**, and prescriptive data **106**. At block **208**, at least one of descriptive data **102**, diagnostic data **104**, predictive data **106**, and prescriptive data **108** is determined in response to at least the transport parameters **82**.

At block **210**, different data **100** is transmitted to the user device **110** (e.g., or the user device is granted access to it via an internet connection) depending upon the customer license **88** associated with the user device **110**. At block **210***a*, descriptive data **102** is transmitted to the user device **110** if the user device **110** has a customer license **88** for descriptive data **102**. At block **210***b*, diagnostic data **104** is transmitted to the user device **110** if the user device **110** has a customer license **88** for diagnostic data **104**. At block **210***c*, predictive data **106** is transmitted to the user device **110** if the user device **110** has a customer license **88** for predictive data **106**. At block **210***d*, prescriptive data **108** is transmitted to the user device **110** if the user device **110** has a customer license **88** for prescriptive data **88**.

The method **200** may further comprise storing historical transport parameters **84** for the transport refrigeration system **20** and/or storing a maintenance history **86** of the transportation refrigeration system **20**. The descriptive data **102** may be determined in response to the at least one of the transport parameters **82**, the historical transport parameters **84**, and the maintenance history **86**. The diagnostic data **104** may be determined in response to the at least one of the transport parameters **82**, the historical transport parameters **84**, and the maintenance history **86**. The predictive data **106** may be determined in response to the at least one of the transport parameters **82**, the historical transport parameters **84**, and the maintenance history **86**. The prescriptive data **108** may be determined in response to the at least one of the transport parameters **82**, the historical transport parameters **84**, and the maintenance history **86**.

While the above description has described the flow process of FIG. **2** in a particular order, it should be appreciated that unless otherwise specifically required in the attached claims that the ordering of the steps may be varied.

As described above, embodiments can be in the form of processor-implemented processes and devices for practicing those processes, such as a processor. Embodiments can also be in the form of computer program code containing instructions embodied in tangible media, such as network cloud storage, SD cards, flash drives, floppy diskettes, CD ROMs, hard drives, or any other computer-readable storage medium, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes a device for practicing the embodiments. Embodiments can also be in the form of computer program code, for example, whether stored in a storage medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein, when the computer program code is loaded into an executed by a computer, the computer becomes a device for practicing the embodiments. When implemented on a general-purpose microprocessor, the computer program code segments configure the microprocessor to create specific logic circuits.

The term "about" is intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, "about" can include a range of ±8% or 5%, or 2% of a given value.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, element components, and/or groups thereof.

While the present disclosure has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this present disclosure, but that the present disclosure will include all embodiments falling within the scope of the claims.

What is claimed is:

1. A system for analyzing a transport refrigeration system, the system comprising:

a storage device to store transport parameters associated with a transport refrigeration system and customer licenses;

a diagnostics engine in electronic communication with the storage device, the diagnostics engine including:

a license module to determine whether a user device has a customer license for at least one of descriptive data, diagnostic data, predictive data, and prescriptive data;

a descriptive module to determine descriptive data in response to at least the transport parameters and transmit the descriptive data to the user device if the user device has a customer license for descriptive data;

a diagnostic module to determine diagnostic data of the transport refrigeration unit in response to at least the transport parameters and transmit the diagnostic data to the user device if the user device has a customer license for diagnostic data;

a predictive module to determine predictive data in response to at least the transport parameters and transmit the predictive data to the user device if the user device has a customer license for predictive data; and

a prescriptive module to determine prescriptive data in response to at least the transport parameters and transmit the prescriptive data to the user device if the user device has a customer license for prescriptive data.

2. The system of claim **1**, wherein:

the storage device stores historical transport parameters for the transport refrigeration system.

3. The system of claim **2**, wherein:

the descriptive module determines descriptive data in response to the transport parameters and historical transport parameters.

4. The system of claim **2**, wherein:

the diagnostic module determines diagnostic data in response to the transport parameters and historical transport parameters.

5. The system of claim **2**, wherein:

the predictive module determines predictive data in response to the transport parameters and historical transport parameters.

6. The system of claim **2**, wherein:

the prescriptive module determines prescriptive data in response to the transport parameters and historical transport parameters.

7. The system of claim **1**, wherein:

the storage device stores a maintenance history of the transportation refrigeration system.

8. The system of claim **7**, wherein:

the descriptive module determines descriptive data in response to the transport parameters and the maintenance history.

9. The system of claim **7**, wherein:

the diagnostic module determines diagnostic data in response to the transport parameters and the maintenance history.

10. The system of claim **7**, wherein:

the predictive module determines predictive data in response to the transport parameters and the maintenance history.

11. The system of claim **7**, wherein:

the prescriptive module determines prescriptive data in response to the transport parameters and the maintenance history.

12. A method for analyzing a transport refrigeration system, the method comprising:

storing transport parameters associated with a transport refrigeration system and customer licenses;

determining whether a user device has a customer license for at least one of descriptive data, diagnostic data, predictive data, and prescriptive data;

determining at least one of descriptive data, diagnostic data, predictive data, and prescriptive data in response to at least the transport parameters;

transmitting the descriptive data to the user device if the user device has a customer license for descriptive data;

transmitting the diagnostic data to the user device if the user device has a customer license for diagnostic data;

transmitting the predictive data to the user device if the user device has a customer license for predictive data; and

transmitting the prescriptive data to the user device if the user device has a customer license for prescriptive data.

13. The method of claim **12**, further comprising:

storing historical transport parameters for the transport refrigeration system.

14. The method of claim **13**, wherein:

the descriptive data is determined in response to the transport parameters and historical transport parameters.

15. The method of claim **13**, wherein:

the diagnostic data is determined in response to the transport parameters and historical transport parameters.

16. The method of claim **13**, wherein:

the predictive data is determined in response to the transport parameters and historical transport parameters.

17. The method of claim **13**, wherein:

the prescriptive data is determined in response to the transport parameters and historical transport parameters.

18. The method of claim **12**, further comprising:

storing a maintenance history of the transportation refrigeration system.

19. The method of claim **18**, wherein:

the descriptive data is determined in response to the transport parameters and the maintenance history.

20. The method of claim **18**, wherein:

the diagnostic data is determined in response to the transport parameters and the maintenance history.

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